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ORIENTATION-ERROR ACCIDENTS IN REGULAR ARMY UH-1 AIRCRAFT
DURING FISCAL YEAR 1970: RELATIVE INCIDENCE AND COST

Jorma I. Niven, W. Carroll Hixson, and Emil Spezia



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SUMMARY PAGE

THE PROBLEM

From the military mission viewpoint, the amount of research effort to be expended on the solution of a given aviation medicine problem must be keyed to the operational cost of the problem. Therefore, a necessary first step in the development of a solution is the assimilation of data that define the magnitude of the problem. Though orientation-error accidents involving pilot disorientation and vertigo have been long recognized to exist, little quantitative data are available to describe the actual incidence and cost of such accidents in Army aviation.

FINDINGS

To initiate the action necessary to establish the magnitude of the orientation-error problem in Army aviation, an interservice research program was organized under the joint sponsorship of the U. S. Army Aeromedical Research Laboratory, the U. S. Army Agency for Aviation Safety, and the Naval Aerospace Medical Research Laboratory. The first task was the construction of an operational definition of an orientation-error accident. The assimilation of data pertaining to the incidence and cause of such accidents and their actual and relative costs in terms of fatalities, injuries, and aircraft damage was then set as the working objective of the program. Accordingly, the decision was made to implement a five-year longitudinal study of all major and minor orientation-error accidents involving Regular Army flight operations beginning with fiscal year 1967. Findings are being summarized on a fiscal-year basis in three separate lines of reports: The first line is devoted to defining the over-all magnitude of the orientation-error problem in all aircraft types; the second line to the presentation of similar incidence and cost data for accidents involving only the UH-1 aircraft, the predominant rotary wing aircraft in the Army inventory; and the third line to the description of the various causal factors found to be present in the major UH-1 orientation-error accidents.

This specific report is the fourth in the series dealing with the magnitude of the orientation-error problem in UH-1 aircraft. Incidence and cost data are presented for all major and minor orientation-error accidents involving Regular Army UH-1 flight operations that were detected in the search of the fiscal year 1970 accident files.

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

ACKNOWLEDGMENTS

The authors wish to thank Colonel R. W. Bailey, MSC, USA, Commanding Officer, U. S. Army Aeromedical Research Laboratory, for his direction and assistance in the initial setup and structure of the project and for his continued support of its research objectives. The authors wish to thank also the director of the U. S. Army Agency for Aviation Safety and his data processing staff for making the master accident files available for analysis and for compiling the all-accident and pilot-error accident statistics included in this specific report. In addition, we acknowledge the assistance of Mrs. Linda Pearce of the Naval Aerospace Medical Research Laboratory (NAMRL) in the conduct of the orientation-error accident analysis program and to thank her for the sustained, always cheerful, working support she has devoted to the accomplishment of the project objectives. Other NAMRL personnel whom the authors wish to thank include Mr. A. N. Dennis and Mr. C. A. Lowery, both of the Bionics Branch, who assisted in the compilation and graphical layout of the data, and Mr. R. C. Barrett of the Visual Aids Branch who photographed the report figures.

LIST OF TABLES

| | Page |
|---|------|
| Table I. All Accident Types | 4 |
| Table II. Pilot-Error Accidents Only | 10 |
| Table III. Orientation-Error Accidents Only | 14 |

LIST OF FIGURES

| | |
|---|----|
| Figure 1A. Weighting Factor: Total UH-1 Flying Hours | 5 |
| Figure 1B. Weighting Factor: Total UH-1 Landings | 5 |
| Figure 2. All UH-1 Accident Types: Incidence of Major and Minor Accidents | 6 |
| Figure 3A. All UH-1 Accident Types: Total Number of Fatal Accidents | 7 |
| Figure 3B. All UH-1 Accident Types: Total Number of Fatalities | 7 |
| Figure 3C. All UH-1 Accident Types: Total Number of Nonfatal Injuries | 7 |
| Figure 3D. All UH-1 Accident Types: Total Aircraft Dollar Damage | 7 |
| Figure 4A. All UH-1 Accident Types: Accident Rate per 100,000 Hours | 8 |
| Figure 4B. All UH-1 Accident Types: Accident Rate per 100,000 Landings | 8 |
| Figure 5. UH-1 Pilot-Error Accident Types: Incidence of Major and Minor Accidents | 11 |
| Figure 6A. UH-1 Pilot-Error Accident Types: Total Number of Fatal Accidents | 12 |
| Figure 6B. UH-1 Pilot-Error Accident Types: Total Number of Fatalities | 12 |
| Figure 6C. UH-1 Pilot-Error Accident Types: Total Number of Nonfatal Injuries | 12 |
| Figure 6D. UH-1 Pilot-Error Accident Types: Total Aircraft Dollar Damage | 12 |
| Figure 7A. UH-1 Pilot-Error Accident Types: Accident Rate per 100,000 Hours | 13 |
| Figure 7B. UH-1 Pilot-Error Accident Types: Accident Rate per 100,000 Landings | 13 |
| Figure 8. UH-1 Orientation-Error Accident Types: Incidence of Major and Minor Accidents | 15 |
| Figure 9A. UH-1 Orientation-Error Accident Types: Total Number of Fatal Accidents | 16 |
| Figure 9B. UH-1 Orientation-Error Accident Types: Total Number of Fatalities | 16 |
| Figure 9C. UH-1 Orientation-Error Accident Types: Total Number of Nonfatal Injuries | 16 |
| Figure 9D. UH-1 Orientation-Error Accident Types: Total Aircraft Dollar Damage | 16 |
| Figure 10A. UH-1 Orientation-Error Accident Types: Accident Rate per 100,000 Hours | 17 |
| Figure 10B. UH-1 Orientation-Error Accident Types: Accident Rate per 100,000 Landings | 17 |

| | Page |
|---|------|
| Figure 11. Comparative Costs: Percent Fatal Accidents | 19 |
| Figure 12. Comparative Costs: Average Number Fatalities per Fatal Accident | 20 |
| Figure 13. Comparative Costs: Average Number Nonfatal Injuries per Accident | 21 |
| Figure 14. Comparative Costs: Average Dollar Damage per Accident | 22 |
| Figure 15. UH-1 Orientation-Error Accidents: Percent Total Incidence | 23 |
| Figure 16. UH-1 Orientation-Error Accidents: Percent Total Fatal Accidents | 24 |
| Figure 17. UH-1 Orientation-Error Accidents: Percent Total Fatalities | 25 |
| Figure 18. UH-1 Orientation-Error Accidents: Percent Total Dollar Cost | 26 |

INTRODUCTION

To investigate the operational role of pilot disorientation and vertigo in the production of orientation-error type aircraft accidents, the authors have organized an inter-service research program under the joint sponsorship of the U. S. Army Aeromedical Research Laboratory (USAARL), the U. S. Army Agency for Aviation Safety (USAAVS), and the Naval Aerospace Medical Research Laboratory (NAMRL). Since little quantified data were available to describe the actual magnitude of the orientation-error problem in Regular Army flight operations, the decision was made to conduct a five-year longitudinal study, beginning with fiscal year 1967, of all Army aircraft accidents that involved an erroneous judgment of aircraft motion or attitude on the part of the pilot. Two separate, but related, project objectives were set for the longitudinal study. The first was to extract and assimilate data from the USAAVS master aircraft-accident files which would define the actual and relative cost of orientation-error accidents to Regular Army flight operations. These data, by defining the operational magnitude of the problem, would then serve to define the extent of the research support which should be devoted to its solution. The second working objective was to extract data on a case-history basis which would describe the various pilot/aircraft/mission/environment factors found to be present in each of the orientation-error accidents. Assimilation and analysis of these data over the study period would result in better knowledge of the most common operational causes of orientation-error accidents and thus point out those research directions which offer the greatest potential toward the reduction of accident incidence.

The results of the longitudinal study are being summarized in three separate lines of reports, with one report in each line prepared for each fiscal year of the five-year study. The first line of reports (for example, ref. 1) is devoted to defining the incidence and cost of all major and minor orientation-error accidents involving all aircraft types, fixed wing as well as rotary wing, that occurred in Regular Army flight operations for each fiscal year. Since the UH-1 "Huey" helicopter has been, and is, the predominant aircraft in the Army rotary wing inventory, the second line of reports (for example, ref. 2) is devoted to defining the magnitude of the orientation-error accident problem in only this aircraft. The layout and format of this line of reports is almost identical to that of the first line. The third line of reports (for example, ref. 3) deals exclusively with the various causal factors found to be present in all of the major UH-1 orientation-error accidents. Typical data to be presented include phase of flight, time of day, type of mission, pilot experience, physiological factors, psychological factors, facility factors, environmental factors, and the like.

This specific report is the fourth in the series dealing with the magnitude of the orientation-error problem in UH-1 aircraft. Incidence and cost data are presented for all major and minor orientation-error accidents involving Regular Army UH-1 flight operations that were detected in the search of the fiscal year 1970 accident files. In addition, corresponding cost data are presented for both all accident types, regardless of cause, and for pilot-error accident types so as to better establish the relative magnitude of the UH-1 orientation-error accident problem.

PROCEDURE

A basic requirement for the commencement of this study was a workable definition of the class of accidents to be defined as involving orientation error. The reader is referred to previous reports(refs. 1-3) for a comprehensive definition and discussion of its rationale. Briefly, orientation is considered to involve the correct determination of the dynamic position and attitude of an aircraft in three-dimensional space. The key word here is dynamic, which implies that full knowledge of the motion as well as static attitude and position is required to define its instantaneous spatial orientation. Accordingly, a pilot is considered to have made an orientation error whenever his perception of the motion and attitude of his aircraft differs from the true motion or attitude; i.e., the true orientation of the aircraft. An orientation-error accident is then defined as one that occurs as a result of an incorrect control or power action taken by a pilot (or a correct action not taken) due to his incorrect perception of the true orientation of his aircraft.

With this definition of orientation-error accidents serving as a classification reference, an experienced classifier read all briefs in the USAAVS master accident files and selected all major and minor accidents of this type occurring during fiscal year 1970. For redundancy, the entire accident files were also searched by sifting the coded summaries that USAAVS prepares for each accident for a wide range of indicator terms.

The authors then reviewed the accident briefs independently for the purpose of establishing whether or not an orientation-error accident classification would result. In addition, the comprehensive master file on each suspect accident was obtained and reviewed. Whenever there was serious question as to the contribution of orientation error to the accident or where equally weighted alternative causal factors were present, then the accident was not included in the classification. The net effect of this policy is to give a conservative estimate of the magnitude of the orientation-error accident problem.

RESULTS AND DISCUSSION

To place the operational significance of UH-1 orientation-error accidents in proper perspective, it is necessary to have at least a cursory understanding of the incidence and cost of UH-1 aircraft accidents in general. As with the previous UH-1 reports(refs. 2,5,8) this is accomplished as follows: The lead section below is devoted to describing the over-all cost of all Army UH-1 aircraft accidents, regardless of type or location, that occurred during fiscal year 1970. In a second section, equivalent data in a nearly identical format are presented to isolate those UH-1 accidents in the first section that were classified by USAAVS as involving one or more pilot-error factors. Incidence and cost statistics pertaining to UH-1 orientation-error accidents only are then presented in a third section. By using these three sets of data as independent references, it then becomes possible to derive some quantitative insight into the relative, as well as actual, cost of UH-1 orientation-error accidents in Army flight operations. Selected comparative relationships are presented in the last section of the report.

To facilitate the point-by-point comparison of these fiscal year 1970 UH-1 data with corresponding data derived for other fiscal years of the longitudinal study, the layout and numbering of all tables and figures in this report follows identically that used in the previous UH-1 reports (refs. 2,5,8).

ALL TYPES OF UH-1 AIRCRAFT ACCIDENTS

The data presented in this section describe the incidence and cost of all major and minor UH-1 helicopter accidents involving Regular Army flight operations during fiscal year 1970. Separate data groupings are provided for those accidents that occurred in Vietnam, those accidents that occurred elsewhere, and their combined total. Since the vast majority of the accidents that do not occur in Vietnam (VN) take place within the continental limits of the United States, the abbreviation US is arbitrarily used to denote all accidents that do not occur in Vietnam. It should be realized then that the US data grouping will include a small number of accidents that may have occurred, for example, in Europe, Africa, or elsewhere. A second point to be stressed is that the VN data pertain strictly to accidents, not losses due to enemy action.

In the interpretation of the accident statistics to follow, it becomes possible to compare VN and US accident incidence only when some common measures of aircraft utilization are selected as weighting factors. A similar requirement exists for comparison of accident incidence in one given fiscal year with incidence in other fiscal years. To establish such reference, percent aircraft inventory, total flying hours, and total aircraft landings are used as basic weighting data in this report. These data, as well as the incidence and cost statistics discussed in this section, are summarized in Table I.

The aircraft inventory data listed in Table I show that for fiscal year 1970, the average number of UH-1 aircraft operating out of VN was 53.30 percent of the total UH-1 inventory. This results in a VN/US inventory ratio of 1.14 to 1. The total flight hours and total landings data shown in Figure 1 show an even greater weighting factor for the VN operations; i.e., a VN/US total hour ratio of 2.84 to 1 and a VN/US total landings ratio of 2.34 to 1. Thus for this fiscal year, aircraft utilization in terms of inventory, total hours, and total landings was greatest in VN.

With these aircraft utilization data serving as background reference, it becomes possible to make a weighted interpretation of the raw accident data presented in Table I. Selected excerpts from these data are presented in Figures 2 and 3. The numerical incidence of all major and minor UH-1 aircraft accidents, regardless of type or causal factor, is plotted in Figure 2. The cost of these accidents, as measured by the number of fatal accidents, number of fatalities, number of nonfatal injuries, and aircraft dollar damage is outlined in Figures 3A through 3D, respectively.

In terms of the over-all UH-1 accident problem, these data show that during fiscal year 1970, there were a total of 482 accidents (102 of which were fatal), resulting in 360 fatalities, 682 nonfatal injuries, and a UH-1 aircraft damage cost of \$75,000,046. The Vietnam contribution to this total was 412 accidents (89 of which were fatal),

| TABLE I | | | | |
|--|-------------------|----------------------|------------------|-------------------|
| FISCAL YEAR 1970 DATA | | | | |
| ALL ACCIDENT TYPES | | UH-1 AIRCRAFT ONLY | | |
| ACCIDENT INDEX | U.S. ACCIDENTS | VIETNAM ACCIDENTS | ALL ACCIDENTS | VN to US RATIO |
| Major Accidents | 62 | 399 | 461 | 6.44 |
| Minor Accidents | 8 | 13 | 21 | 1.63 |
| Total Accidents | 70 | 412 | 482 | 5.89 |
| Aircraft Inventory - Percent Total | 46.70 | 53.30 | 100.00 | 1.14 |
| Total Flying Hours | 700,050 | 1,987,384 | 2,687,434 | 2.84 |
| Total Landings | 2,716,529 | 6,346,716 | 9,063,245 | 2.34 |
| Major Accidents per 100,000 Hours | 8.86 | 20.08 | 17.15 | 2.27 |
| Minor Accidents per 100,000 Hours | 1.14 | 0.66 | 0.78 | 0.57 |
| Total Accidents per 100,000 Hours | 10.00 | 20.73 | 17.94 | 2.07 |
| Major Accidents per 100,000 Landings | 2.28 | 6.29 | 5.09 | 2.76 |
| Minor Accidents per 100,000 Landings | 0.30 | 0.21 | 0.23 | 0.70 |
| Total Accidents per 100,000 Landings | 2.58 | 6.49 | 5.32 | 2.52 |
| Total Dollar Cost | 9,168,368.00 | 65,831,678.01 | 75,000,046.00 | 7.18 |
| Average Dollar Cost per Accident | 130,976.69 | 159,785.63 | 155,601.76 | 1.22 |
| Total Fatalities | 30 | 330 | 360 | 11.00 |
| Average Fatalities per Accident | 0.43 | 0.80 | 0.75 | 1.87 |
| Fatal Accidents - Number | 13 | 89 | 102 | 6.85 |
| Fatal Accidents - Percent | 18.57 | 21.60 | 21.16 | 1.16 |
| Average Fatalities per Fatal Accident | 2.31 | 3.71 | 3.53 | 1.61 |
| Total Nonfatal Injuries | 63 | 619 | 682 | 9.83 |
| Average Nonfatal Injuries per Accident | 0.90 | 1.50 | 1.42 | 1.67 |

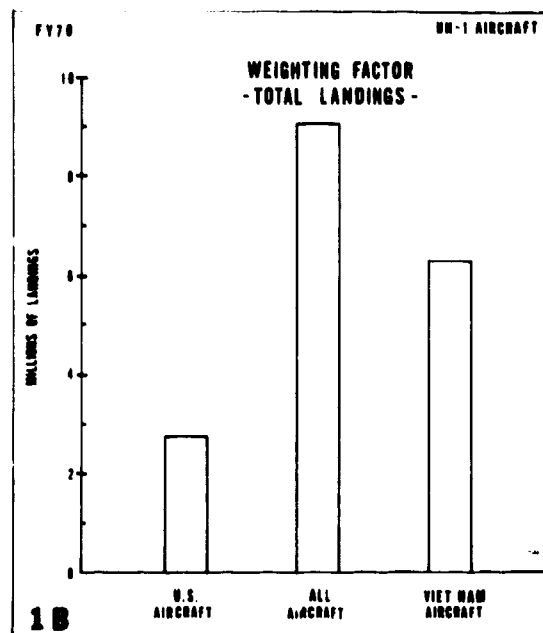
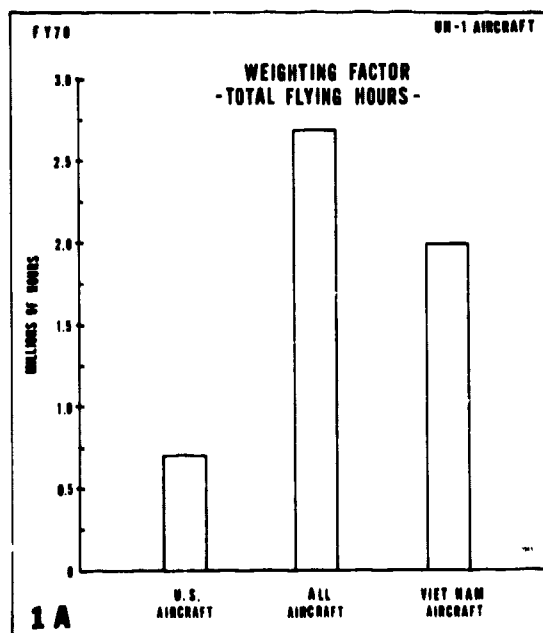


Figure 1

Total flying hours (A) and total landings (B) by location of UH-1 (Huey) helicopter aircraft flown in Regular Army flight operations during fiscal year 1970. In 1A, the right-hand bar indicates total hours flown in Vietnam, the left-hand bar total hours flown elsewhere (primarily in the United States), and the central bar the direct sum of the adjacent data to either side. The format of the total landing data in 1B follows identically. For this year, 2.84 times as many hours were flown in Vietnam as were flown elsewhere. Correspondingly, 2.34 times as many landings were made in Vietnam as were made elsewhere.

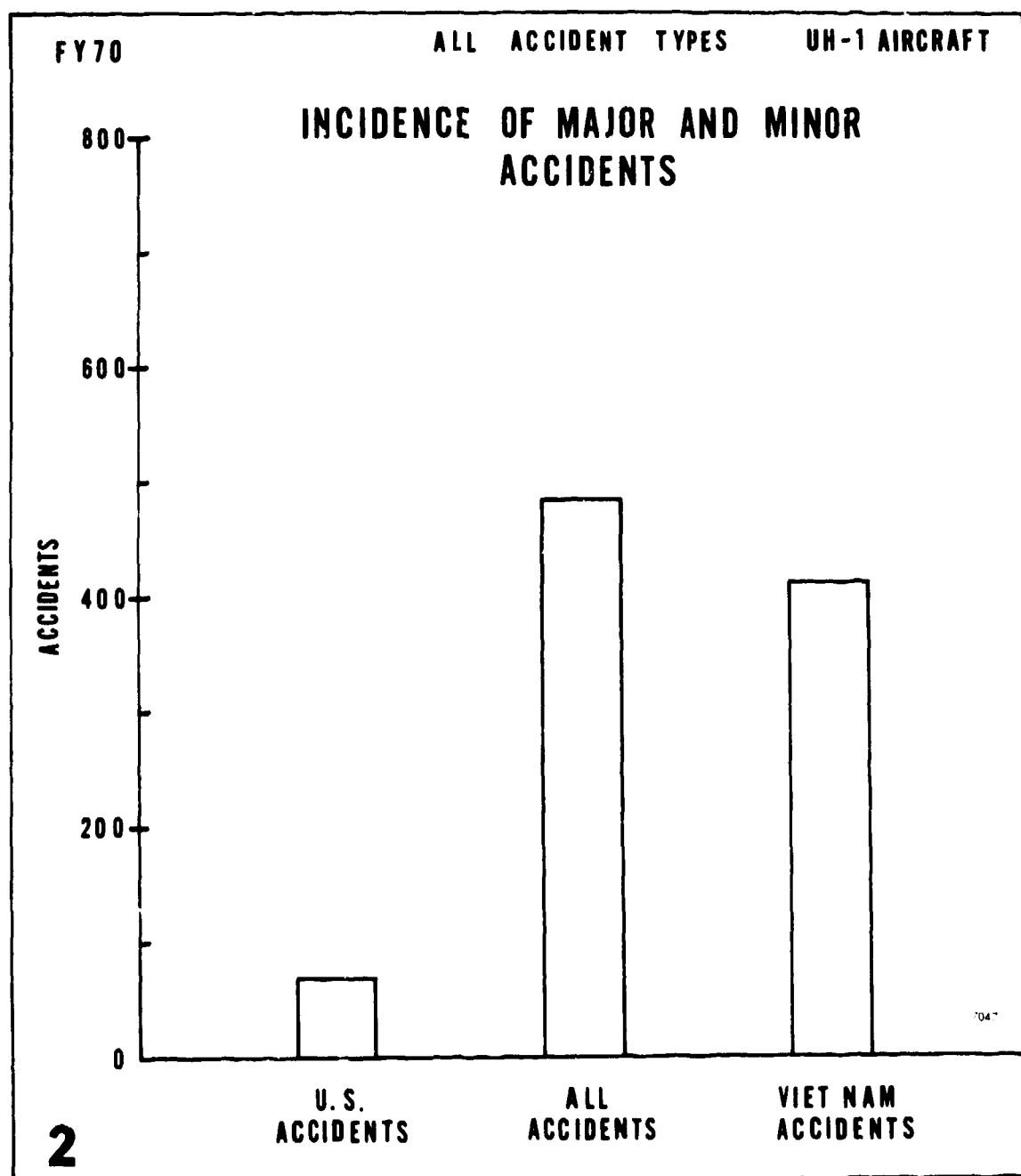


Figure 2

All UH-1 Accident Types: Total number of major and minor UH-1 aircraft accidents of all types that occurred in Regular Army flight operations during fiscal year 1970. The right-hand bar denotes the number of UH-1 accidents that occurred in Vietnam, while the left-hand bar denotes the number of accidents that occurred elsewhere. This latter bar has been identified as "U. S. Accidents" for convenience since the vast majority of the accidents that do not occur in Vietnam (VN) take place within the continental limits of the United States (US). This convention applies throughout the remaining report figures. The central bar totalizes the adjacent VN and US data. As described in the text, the VN data pertain to accidents, not losses due to enemy action. The number of accidents that occurred in VN was 5.89 times the number of accidents that occurred elsewhere.

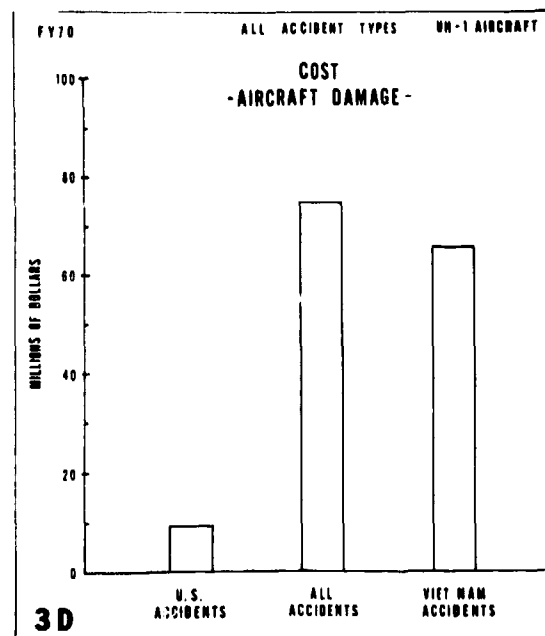
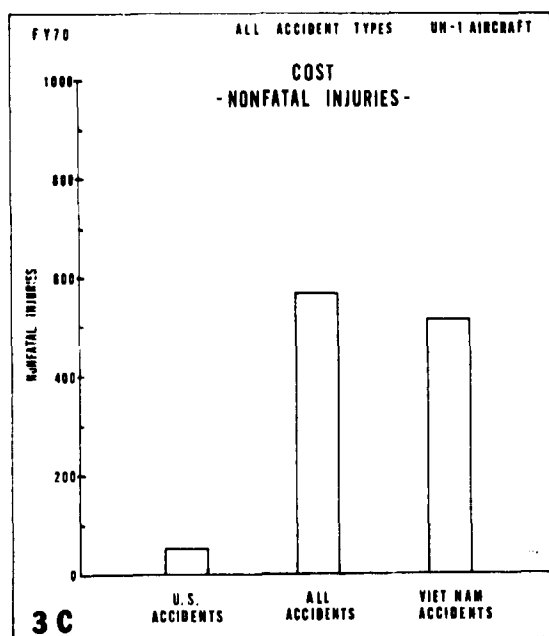
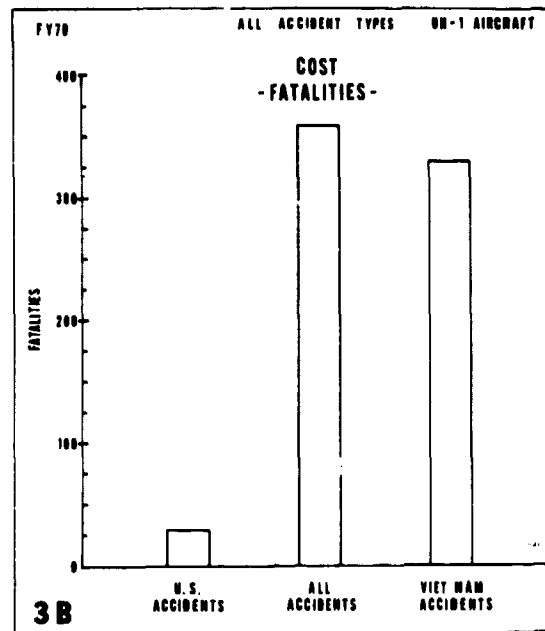
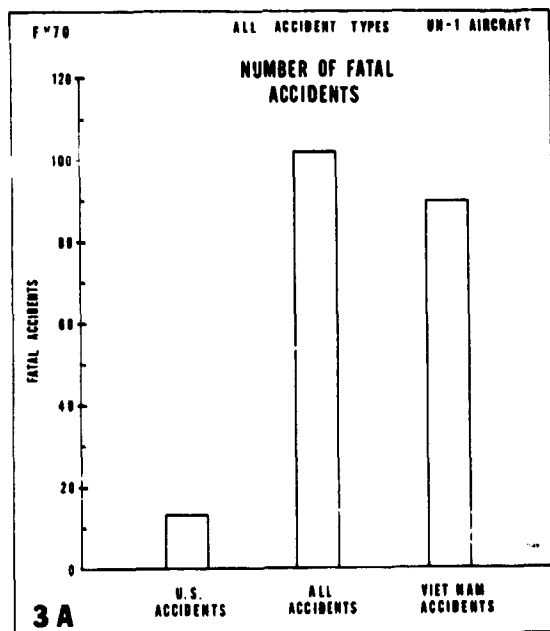


Figure 3

All UH-1 Accident Types: Total number of fatal accidents (A), total number of fatalities (B), total number of nonfatal injuries (C), and total dollar cost of resulting UH-1 aircraft damage (D). In all cases, the VN costs were greater.

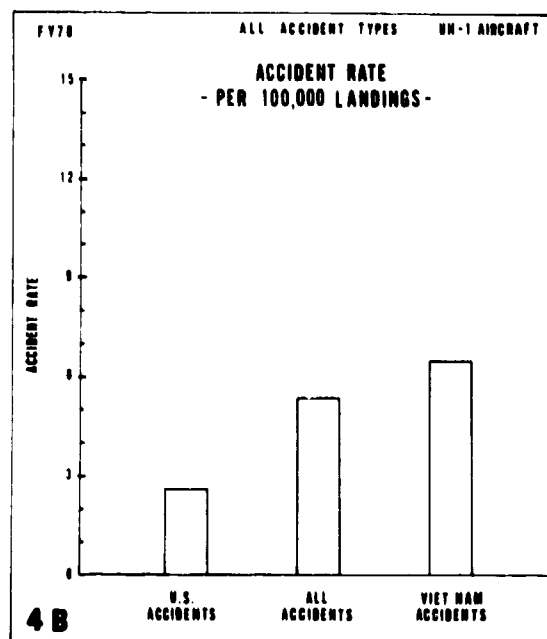
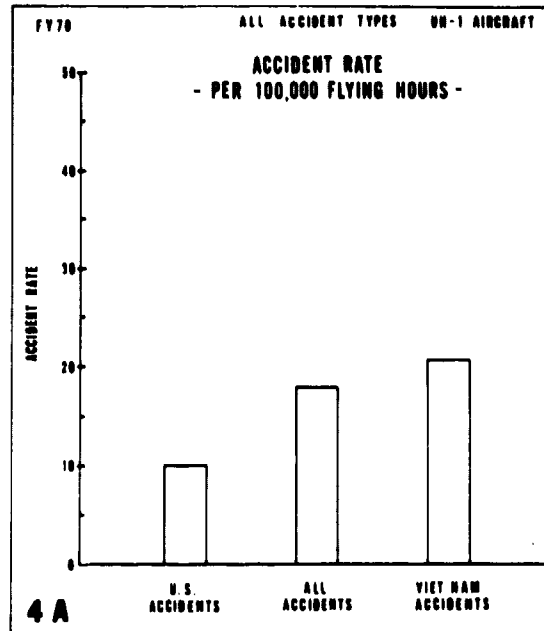


Figure 4

All UH-1 Accident Types: Normalized incidence data showing the average number of UH-1 accidents per 100,000 flying hours (A) and average number of accidents per 100,000 landings (B). The over-all rates were 17.94 accidents per 100,000 hours and 5.32 accidents per 100,000 landings. The VN rate was 2.07 times the US rate using hours as reference and 2.52 times the US rate using landings as reference.

resulting in 330 fatalities, 619 nonfatal injuries, and an aircraft damage cost of \$65,831,678. In all cases, the unweighted incidence and cost of accidents occurring in VN exceeded those of accidents occurring elsewhere. That is, the VN/US total accident ratio was 5.89 to 1, the VN/US total fatal accident ratio was 6.85 to 1, the VN/US total fatality ratio was 11.00 to 1, the VN/US total nonfatal injury ratio was 9.83 to 1, and the VN/US average cost per accident ratio was 1.22 to 1. In terms of total dollar damage, the cost of VN accidents was 7.18 times the cost of US accidents.

To facilitate the comparison of these fiscal year 1970 accident incidence data to accident incidence in other fiscal years covered by the longitudinal study, the data in Figure 2 have been normalized relative to the total number of flying hours flown in each location and plotted in Figure 4A as the average number of accidents occurring every 100,000 hours. The same normalization using total landings as reference was accomplished for Figure 4B, which shows the accident rate for every 100,000 landings. Considering the total number of UH-1 accidents, these data show that, on the average, there were 17.94 accidents per 100,000 hours and 5.32 accidents per 100,000 landings. These rate figures are lower than the corresponding data for fiscal years 1967 (ref. 2), 1968 (ref. 5), and 1969 (ref. 8). The UH-1 data indicate that, even after normalization, the accident rate in VN was substantially greater than that elsewhere. That is, the accident rate in VN was 2.07 times greater than the rate elsewhere using total hours as reference, and 2.52 times greater using total landings as reference.

UH-1 PILOT-ERROR ACCIDENTS

In this section, incidence and cost data are presented for all UH-1 accidents that were classified by USAAVS as involving one or more pilot-error causal factors. It should be observed that this classification does not imply that pilot error was the only, or even the primary, accident causal factor. That is, this grouping includes all UH-1 accidents involving one or more pilot errors even though, for example, material failure, maintenance shortcomings, or poor facilities may also have contributed to the accident. A further point, by definition, is that these pilot-error accidents are a subgroup of the all-accident statistics discussed in the previous section.

Incidence and cost data for these fiscal year 1970 pilot-error accidents are presented in Table II and Figures 5 and 6. These data show that there were a total of 379 major and minor UH-1 pilot-error accidents (82 of which were fatal), resulting in 281 fatalities, 526 nonfatal injuries, and an aircraft damage cost of \$59,469,113. As with the all-accident data, the incidence and cost of pilot-error accidents that occurred in Vietnam were considerably higher than those which occurred elsewhere. From Table II it can be seen that the VN/US accident incidence ratio was 5.65 to 1, the VN/US fatal accident ratio was 5.83 to 1, the VN/US fatality ratio was 9.04 to 1, the VN/US nonfatal injury ratio was 8.93 to 1, and the VN/US average cost per accident ratio was 1.05 to 1. In terms of total dollar damage, the cost of VN accidents was 5.93 times the cost of US accidents. When compared to the corresponding all-accident data, the VN/US fatal accident ratio as well as the VN/US fatality ratio were lower for pilot-error accidents for the first time in this study.

| TABLE II FISCAL YEAR 1970 DATA | | | | |
|--|-------------------|----------------------|------------------|-------------------|
| PILOT-ERROR ACCIDENTS ONLY | | UH-1 AIRCRAFT ONLY | | |
| ACCIDENT INDEX | U.S. ACCIDENTS | VIETNAM ACCIDENTS | ALL ACCIDENTS | VN to US RATIO |
| Major Accidents | 50 | 312 | 362 | 6.24 |
| Minor Accidents | 7 | 10 | 17 | 1.43 |
| Total Accidents | 57 | 322 | 379 | 5.65 |
| Total Dollar Cost | 8,582,274.00 | 50,886,839.01 | 59,469,113.01 | 5.93 |
| Average Dollar Cost per Accident | 150,566.21 | 158,033.66 | 156,910.59 | 1.05 |
| Total Fatalities | 28 | 253 | 281 | 9.04 |
| Average Fatalities per Accident | 0.49 | 0.79 | 0.74 | 1.60 |
| Fatal Accidents - Number | 12 | 70 | 82 | 5.83 |
| Fatal Accidents - Percent | 21.05 | 21.74 | 21.64 | 1.03 |
| Average Fatalities per Fatal Accident | 2.33 | 3.62 | 3.43 | 1.55 |
| Total Nonfatal Injuries | 53 | 473 | 526 | 8.93 |
| Average Nonfatal Injuries per Accident | 0.93 | 1.47 | 1.39 | 1.58 |

In Figure 7, accident rate data are presented using the total hours and total landings data of Figure 1 as normalization reference. The over-all rates were 14.10 accidents per 100,000 hours and 4.18 accidents per 100,000 landings. These pilot-error accident rates are lower than the corresponding data for both fiscal year 1967 (ref. 2) and fiscal year 1968 (ref. 5), but up from fiscal year 1969 (ref. 8). In VN and US, the rates were 16.20 and 8.14 accidents, respectively, per 100,000 hours resulting in a VN/US ratio of 1.99 to 1. With landings as reference, the VN and US rates were 5.07 and 2.10 accidents, respectively, per 100,000 landings, which results in a VN/US ratio of 2.42 to 1.

UH-1 ORIENTATION-ERROR ACCIDENTS

This section summarizes the incidence and cost of all UH-1 major and minor orientation-error accidents detected in our review of the USAAVS accident files for the stated fiscal year. As detailed with selected qualifications in the procedure section of the first report in this series (ref. 2), this listing includes all accidents that were classified as involving incorrect pilot perception of aircraft motion or attitude. The reader should recognize that the orientation-error accidents discussed herein are a subgroup of the pilot-error accident statistics presented in the previous section.

Incidence and cost data for these fiscal year 1970 orientation-error accidents are presented in Table III and Figures 8 and 9. These data show that there were a total of 43 major UH-1 orientation-error accidents (17 of which were fatal), resulting in 66

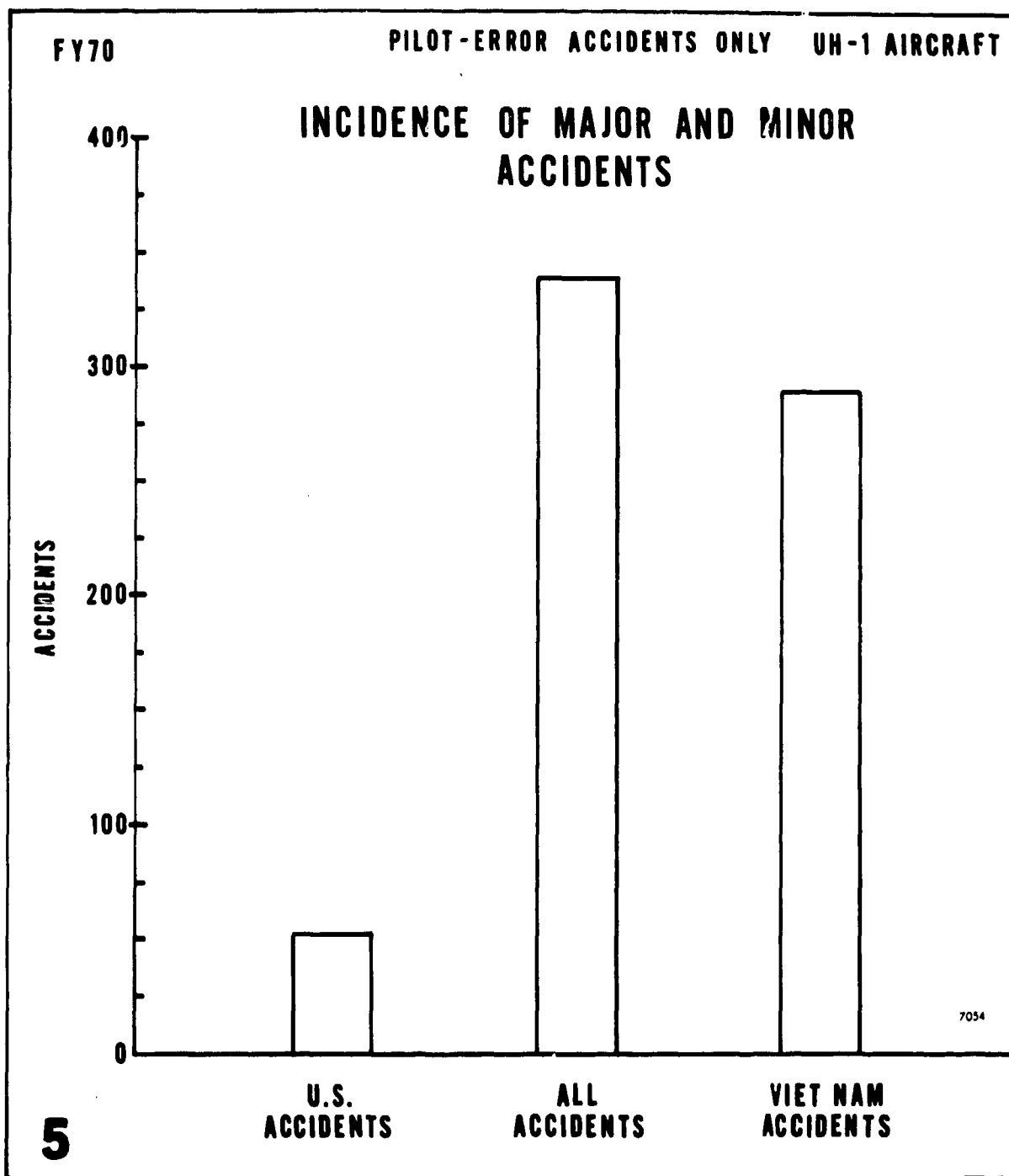


Figure 5

UH-1 Pilot-Error Accident Types: Total number of major and minor UH-1 aircraft accidents involving the presence of one or more pilot-error factors as classified by USAAVS. The number of pilot-error accidents that occurred in VN was 5.65 times the number of accidents that occurred elsewhere.

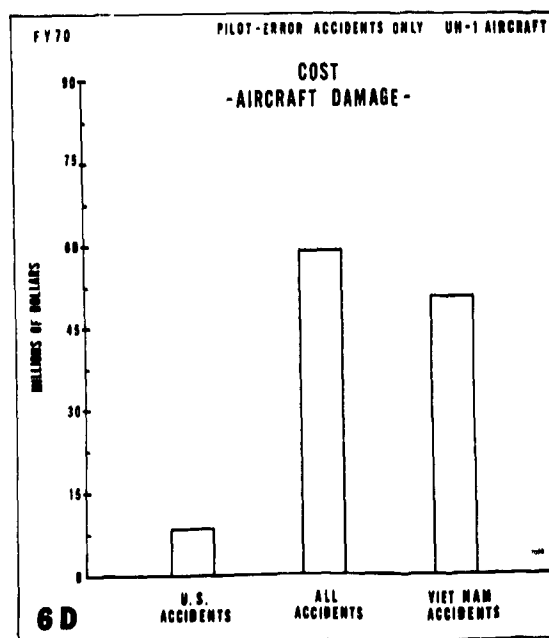
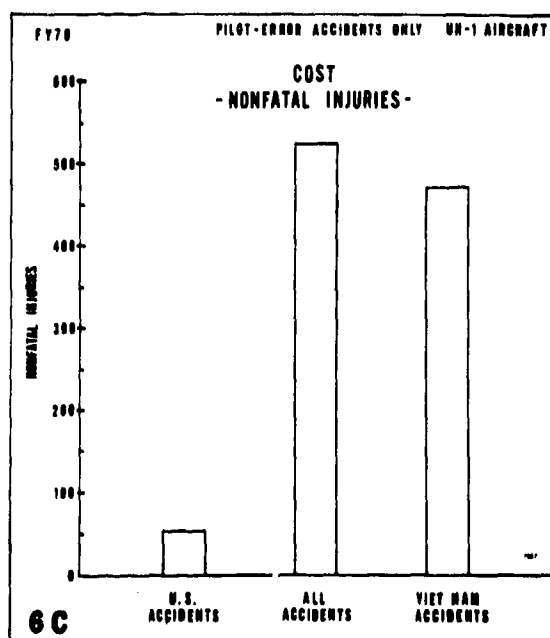
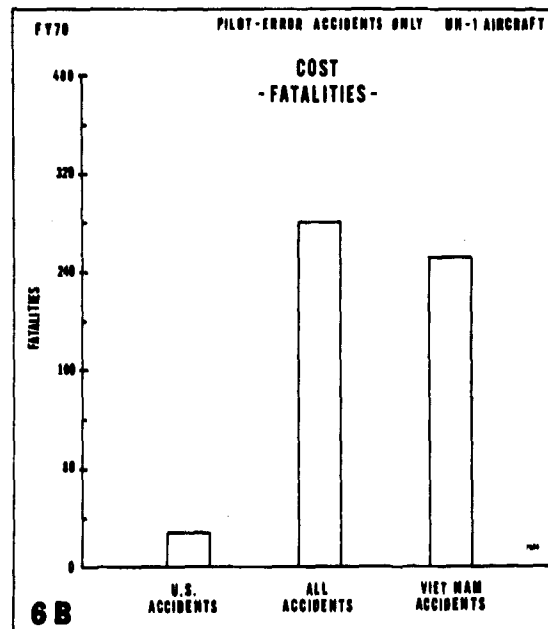
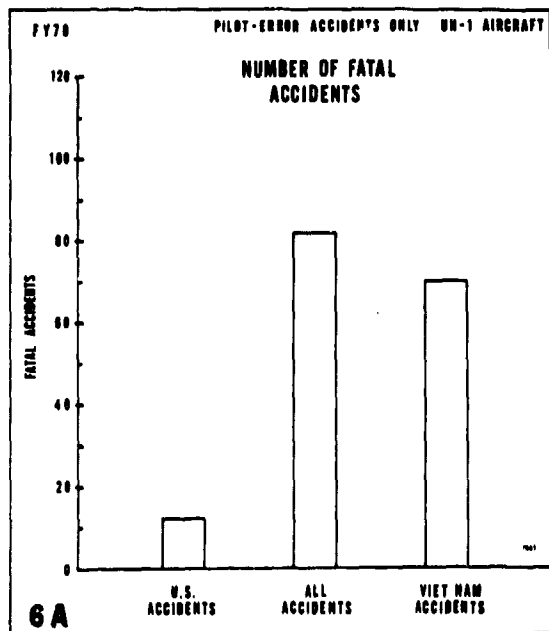


Figure 6

UH-1 Pilot-Error Accident Types: Total number of fatal accidents (A), total number of fatalities (B), total number of nonfatal injuries (C), and total dollar cost of resulting UH-1 aircraft damage (D). As with the all accident data, the loss was greater in VN.

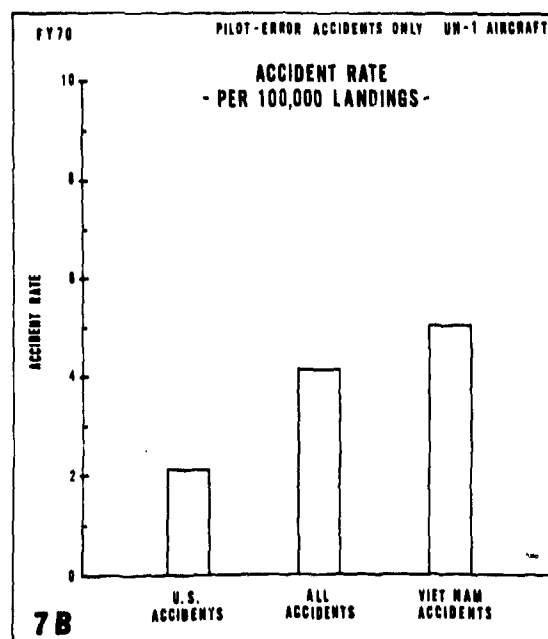
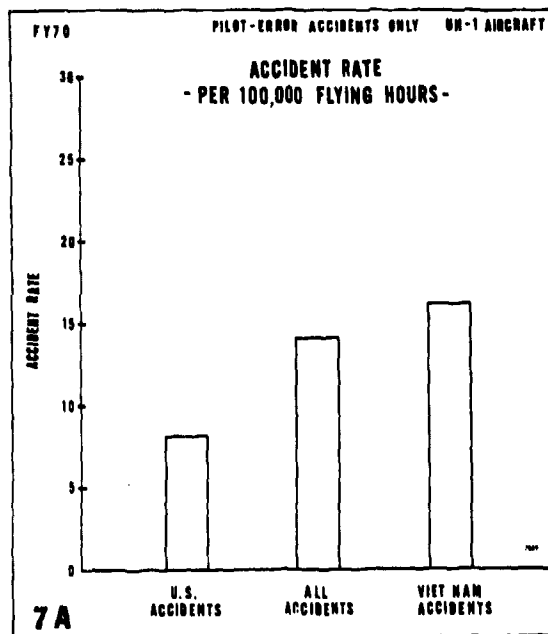


Figure 7

UH-1 Pilot-Error Accident Types: Normalized incidence data showing the average number of UH-1 pilot-error accidents per 100,000 flying hours (A) and average number of accidents per 100,000 landings (B). The total hours and total landings data of Figure 1 served as normalization reference. These rate data are intended only as a fiscal year 1970 baseline reference for comparison with similar data for other fiscal years of the longitudinal study. The over-all rates were 14.10 pilot-error accidents per 100,000 hours and 4.18 accidents per 100,000 landings. The VN rate was 1.99 times the US rate using hours as reference and 2.42 times the US rate using landings as reference.

fatalities, 67 nonfatal injuries, and an aircraft damage cost of \$7,706,191. For this fiscal year, there were no minor accidents. As with the all-accident and pilot-error accident data, the orientation-error data show a much higher accident incidence and personnel cost in VN; i.e., the VN/US total accident incidence ratio was 7.60 to 1, the VN/US fatal accident ratio was indeterminate, and the VN/US nonfatal injury ratio was 10.17 to 1. In the case of the VN/US average dollar cost per accident ratio, the VN cost was higher by 2.00 to 1. With regards to total dollar damage, the cost of orientation-error accidents that occurred in VN was 15.16 times greater than the cost of US accidents.

The accident rate data of Figure 10, derived from the total hours (A) and total landings (B) data of Figure 1, indicate that there was an over-all average of 1.60 and 0.48 orientation-error accidents per 100,000 hours and per 100,000 landings, respectively, for fiscal year 1970. These rates are lower than the corresponding rates for all three preceding fiscal years 1967 (ref. 2), 1968 (ref. 5), and 1969 (ref. 8). As with the all-accident and pilot-error accident data, the orientation-error accident rate was greater in VN. Based on equal flying hours, the VN rate was 2.68 times the US rate; with equal landings as reference, the VN rate was 3.25 times the US rate.

| TABLE III FISCAL YEAR 1970 DATA | | | | |
|--|-------------------|----------------------|------------------|-------------------|
| ORIENTATION-ERROR ACCIDENTS ONLY | | UH-1 AIRCRAFT ONLY | | |
| ACCIDENT INDEX | U.S. ACCIDENTS | VIETNAM ACCIDENTS | ALL ACCIDENTS | VN to US RATIO |
| Major Accidents | 5 | 38 | 43 | 7.60 |
| Minor Accidents | 0 | 0 | 0 | --- |
| Total Accidents | 5 | 38 | 43 | 7.60 |
| Total Dollar Cost | 476,869 | 7,229,322 | 7,706,191 | 15.16 |
| Average Dollar Cost per Accident | 95,373.80 | 190,245.32 | 179,213.75 | 2.00 |
| Total Fatalities | 0 | 66 | 66 | --- |
| Average Fatalities per Accident | 0 | 1.74 | 1.54 | --- |
| Fatal Accidents - Number | 0 | 17 | 17 | --- |
| Fatal Accidents - Percent | 0.00 | 44.74 | 39.54 | --- |
| Average Fatalities per Fatal Accident | 0.00 | 3.88 | 3.88 | --- |
| Total Nonfatal Injuries | 6 | 61 | 67 | 10.17 |
| Average Nonfatal Injuries per Accident | 1.20 | 1.61 | 1.56 | 1.34 |

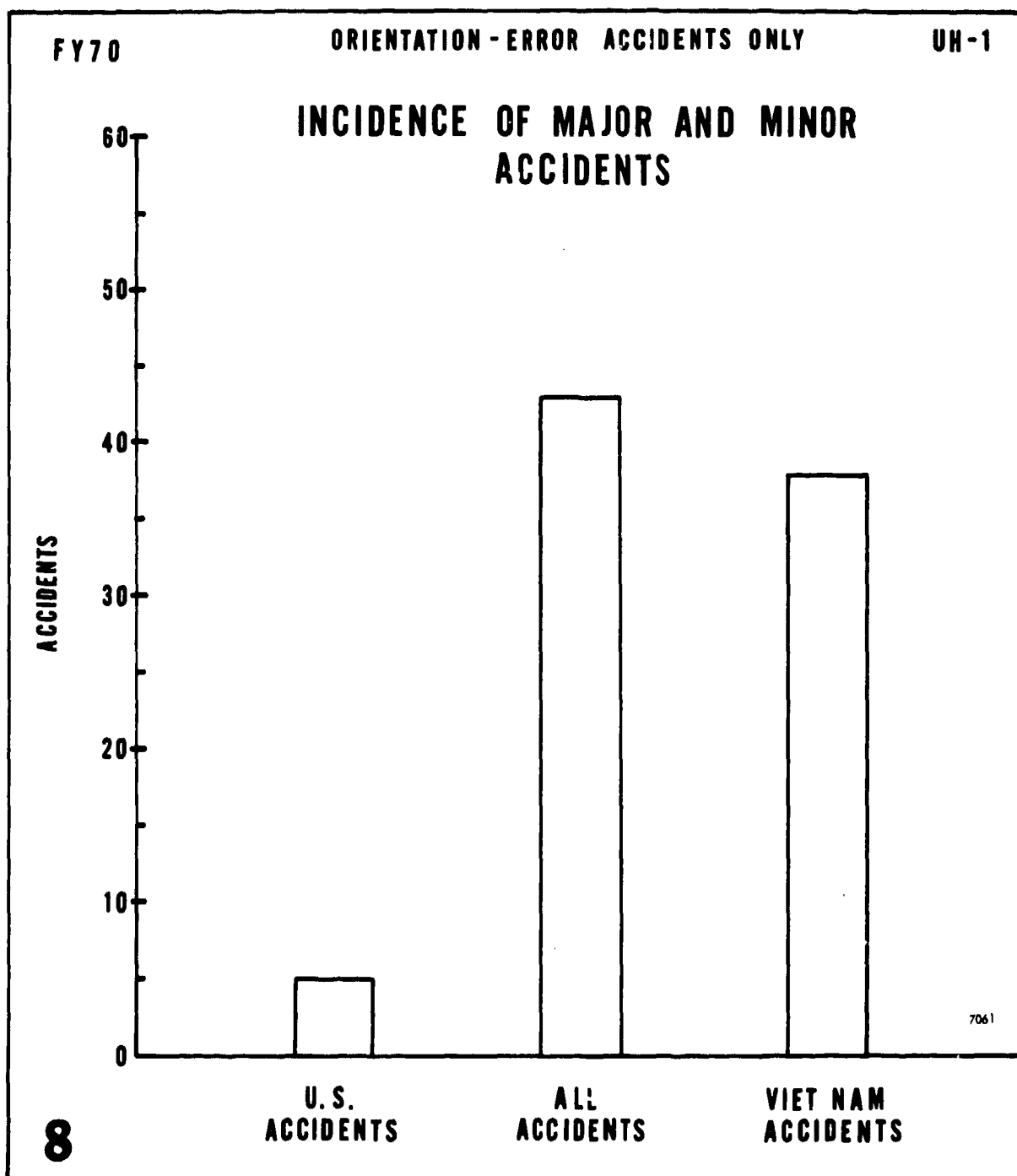


Figure 8

UH-1 Orientation-Error Accident Types: Total number of major and minor UH-1 aircraft accidents involving orientation error that were detected in the search of the USAAVS master accident files for fiscal year 1970. The VN incidence was 7.60 times the US incidence.

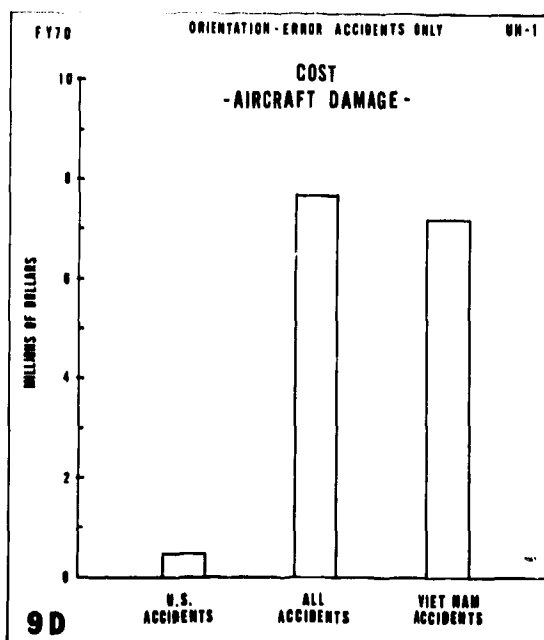
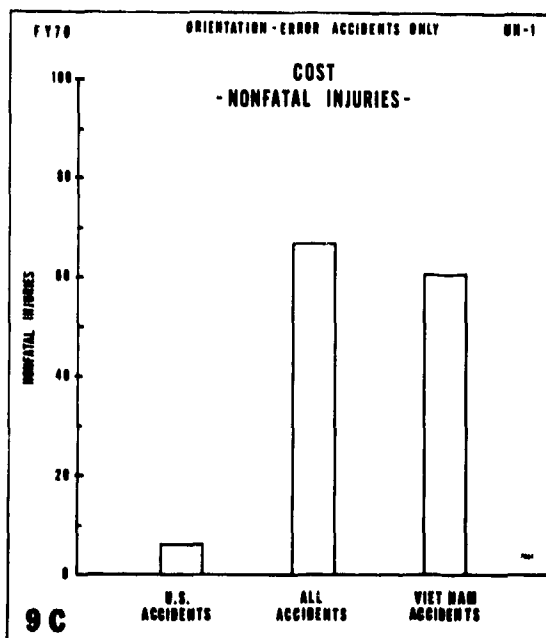
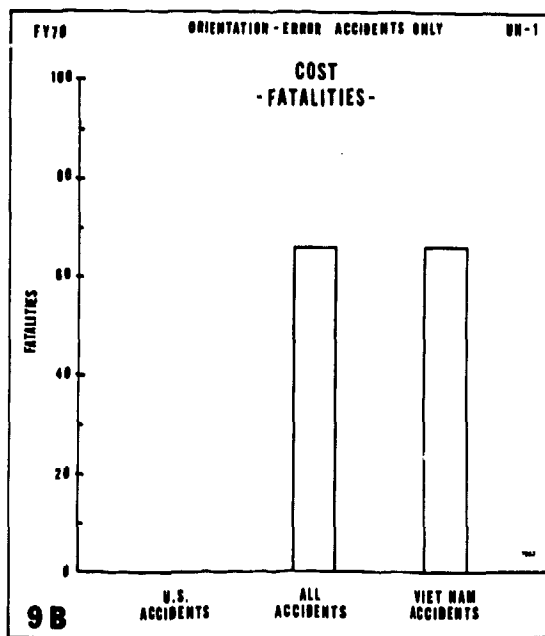
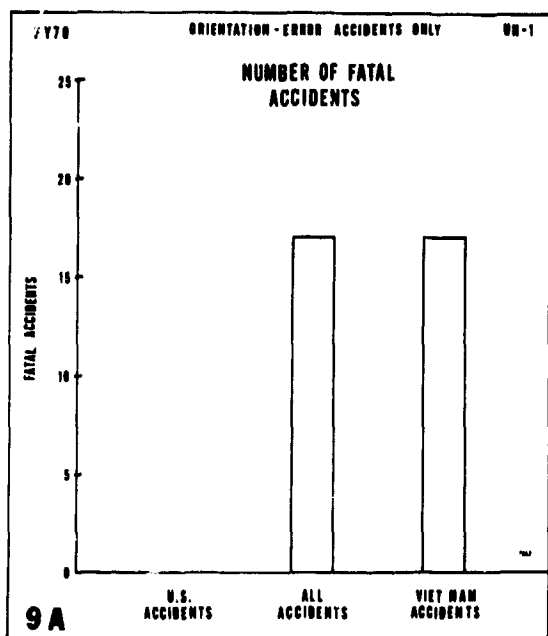


Figure 9

UH-1 Orientation-Error Accident Types: Total number of fatal accidents (A), total number of fatalities (B), total number of nonfatal injuries (C), and total dollar cost of resulting UH-1 aircraft damage (D). The higher cost of VN operations is obvious.

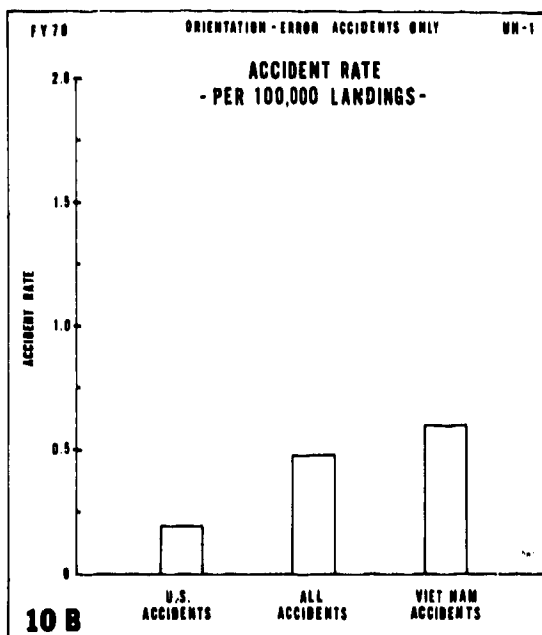
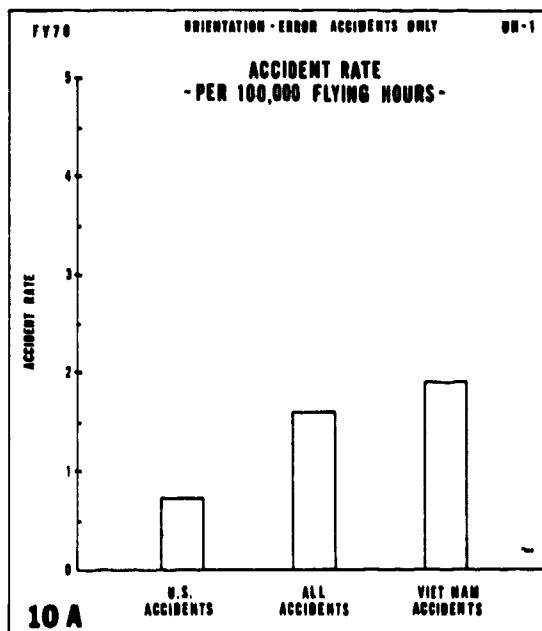


Figure 10

UH-1 Orientation-Error Accident Types: Normalized incidence data showing the average number of UH-1 orientation-error accidents per 100,000 flying hours (A) and average number of accidents per 100,000 landings (B). The total hours and total landings data of Figure 1 served as reference. These rate data are intended only as a fiscal year 1970 baseline reference for comparison with similar data for other fiscal years of the longitudinal study. The over-all rates were 1.60 orientation-error accidents per 100,000 hours and 0.48 accidents per 100,000 landings. The VN rate was 2.68 times the US rate using hours as reference and 3.25 times the US rate using landings as reference.

COMPARATIVE INCIDENCE AND COST OF UH-1 ORIENTATION-ERROR ACCIDENTS

The arrangement of the data presented in the preceding sections was selected to differentiate between the actual incidence and cost of all UH-1 accidents, pilot-error type UH-1 accidents, and orientation-error type UH-1 accidents. In this section, selected incidence and cost data are expressed in percentage figures, with the objective of gaining some insight into the relative contribution of orientation-error accidents to the over-all accident problem.

In Figure 11, the total number of fatal accidents occurring within each of the three accident classifications is expressed as the percentage of the total number of accidents occurring within the given classification. For the combined total of VN and US accidents, 21.16 percent of all accidents were fatal, 21.64 percent of all pilot-error accidents were fatal, and 39.54 percent of all orientation-error accidents were fatal. The probability of a fatal accident was highest when orientation error was present. However, as indicated in Figure 12, when a fatal accident did occur, the average number of fatalities that resulted was about the same for all types, pilot-error, and orientation-error accidents in fiscal year 1970. In terms of the average number of nonfatal injuries resulting from an accident, as indicated in Figure 13, the cost was somewhat higher for orientation-error accidents and lower for pilot-error accidents. The average dollar cost of an accident, as shown in Figure 14, was also higher for the orientation-error class of accidents. The relative magnitude of this damage can be assessed on the basis of the replacement cost of a UH-1 which then was slightly greater than \$250,000.

In Figures 15 through 18, orientation-error accident statistics are expressed as their percent contribution to both the all-accident and pilot-error accident statistics. Thus in Figure 15, the total number of orientation-error accidents is expressed as the percent incidence of the total number of all accidents and percent incidence of the total number of pilot-error accidents. For fiscal year 1970, orientation-error accidents accounted for 8.92 percent of all accidents and 11.35 percent of all pilot-error accidents. For this fiscal year, as in fiscal year 1967, the reader is cautioned to remember not only the low incidence of orientation-error accidents but the absence of any fatal ones in the US.

As shown in Figure 16, the contribution of orientation-error fatal accidents to the over-all fatal accident problem was considerably greater than its contribution to the total accident incidence. Of the total number of fatal accidents of all types, orientation-error accidents accounted for 16.67 percent. Of fatal pilot-error accidents, 20.73 percent were due to orientation error. The same trend follows for total fatalities as indicated in Figure 17. Fatalities due to orientation-error accidents accounted for 18.33 percent of all fatalities, and 23.49 percent of all pilot-error fatalities. In terms of the cost of orientation-error accidents, they contributed 10.28 percent of the total cost of all accidents, and 12.96 percent of the total cost of all pilot-error accidents (Figure 18).

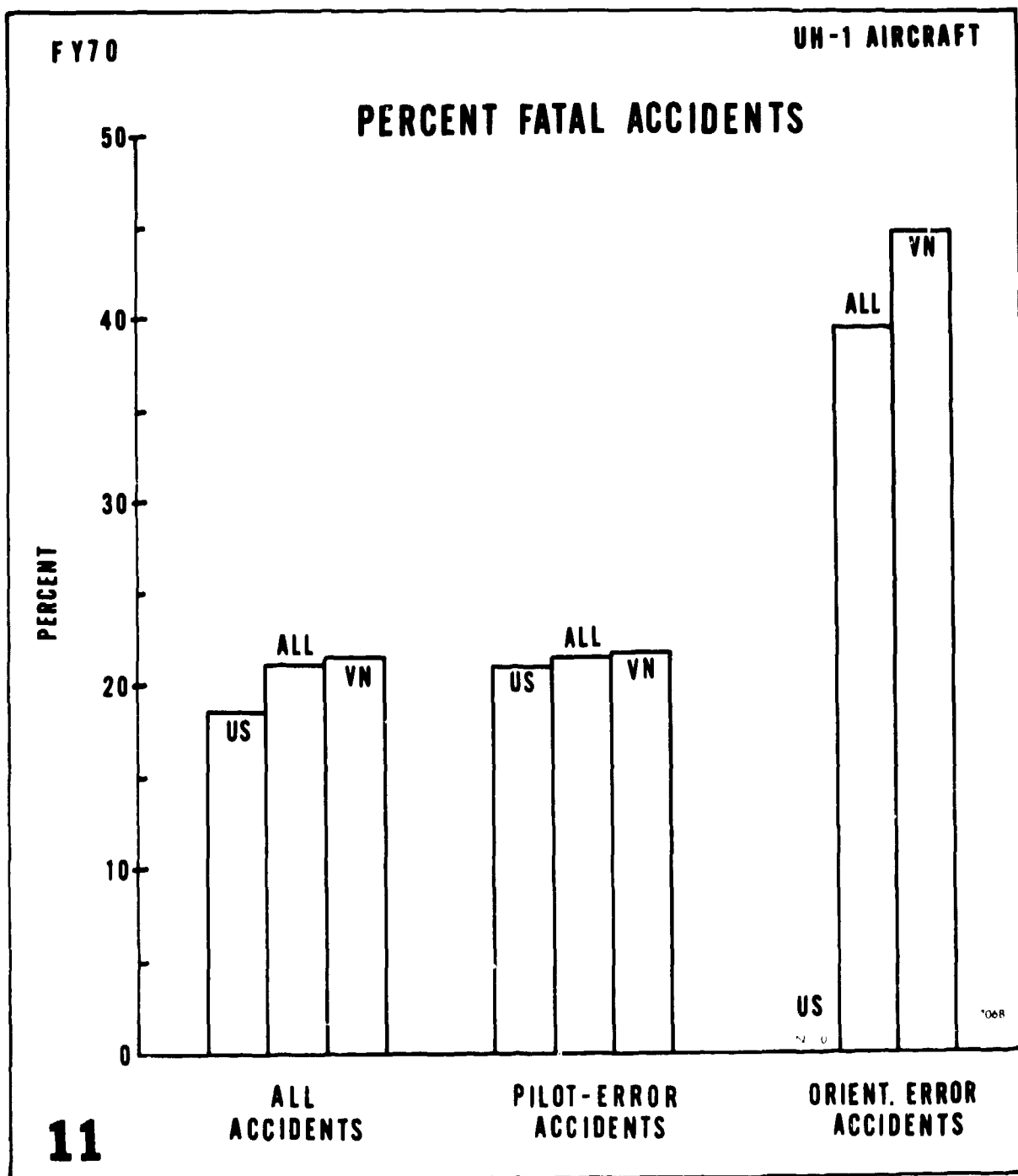


Figure 11

Comparative incidence of fatal accidents expressed as the percent of the total number of accidents within the "All Accident Type," "Pilot-Error Accident Types," and "Orientation-Error Accident Type" classifications that resulted in one or more fatalities. Orientation-error accidents had the greatest percent incidence of fatal accidents.

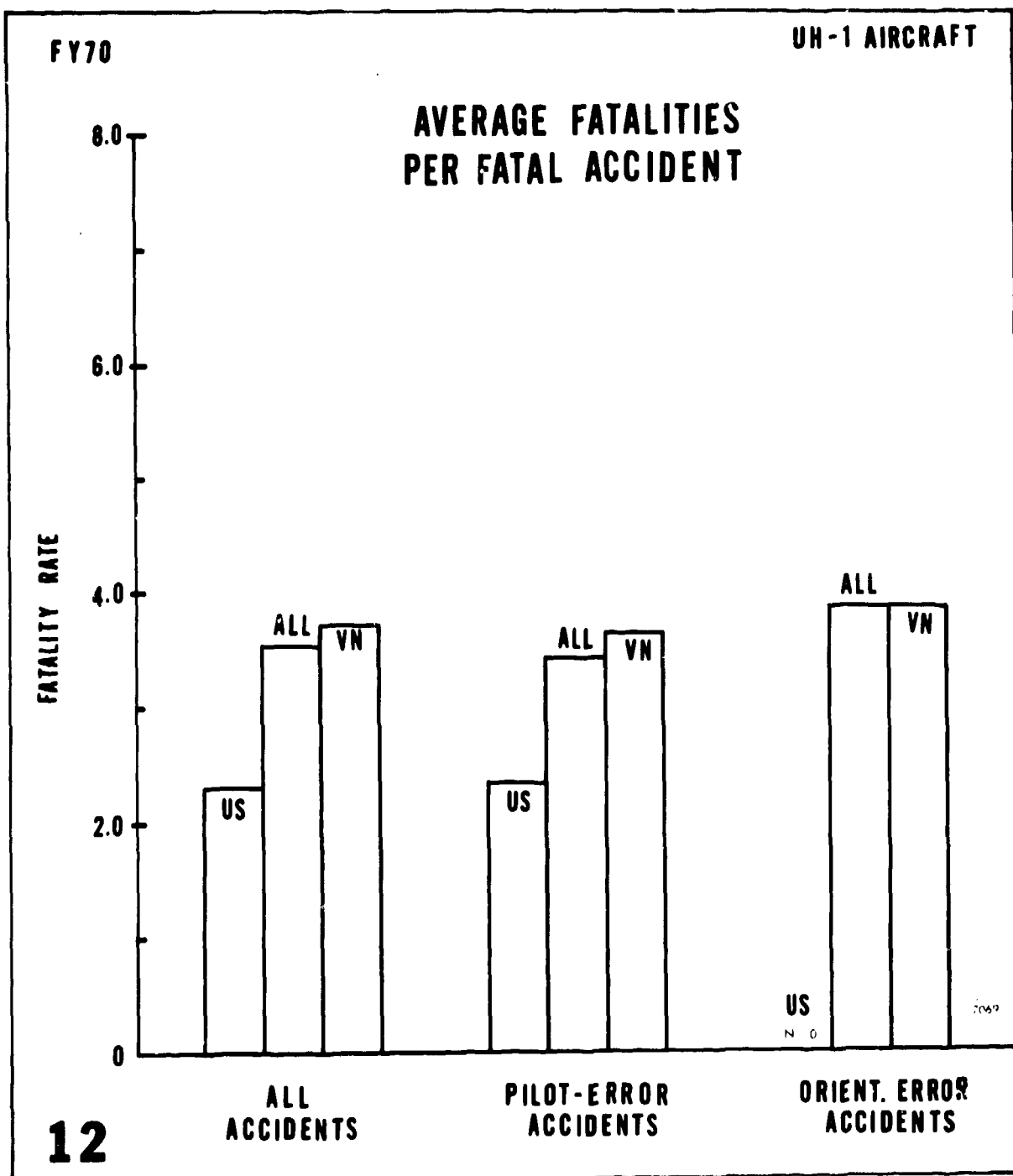


Figure 12

Average number of fatalities per fatal accident for each of the three basic accident type classifications.

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UH-1 AIRCRAFT

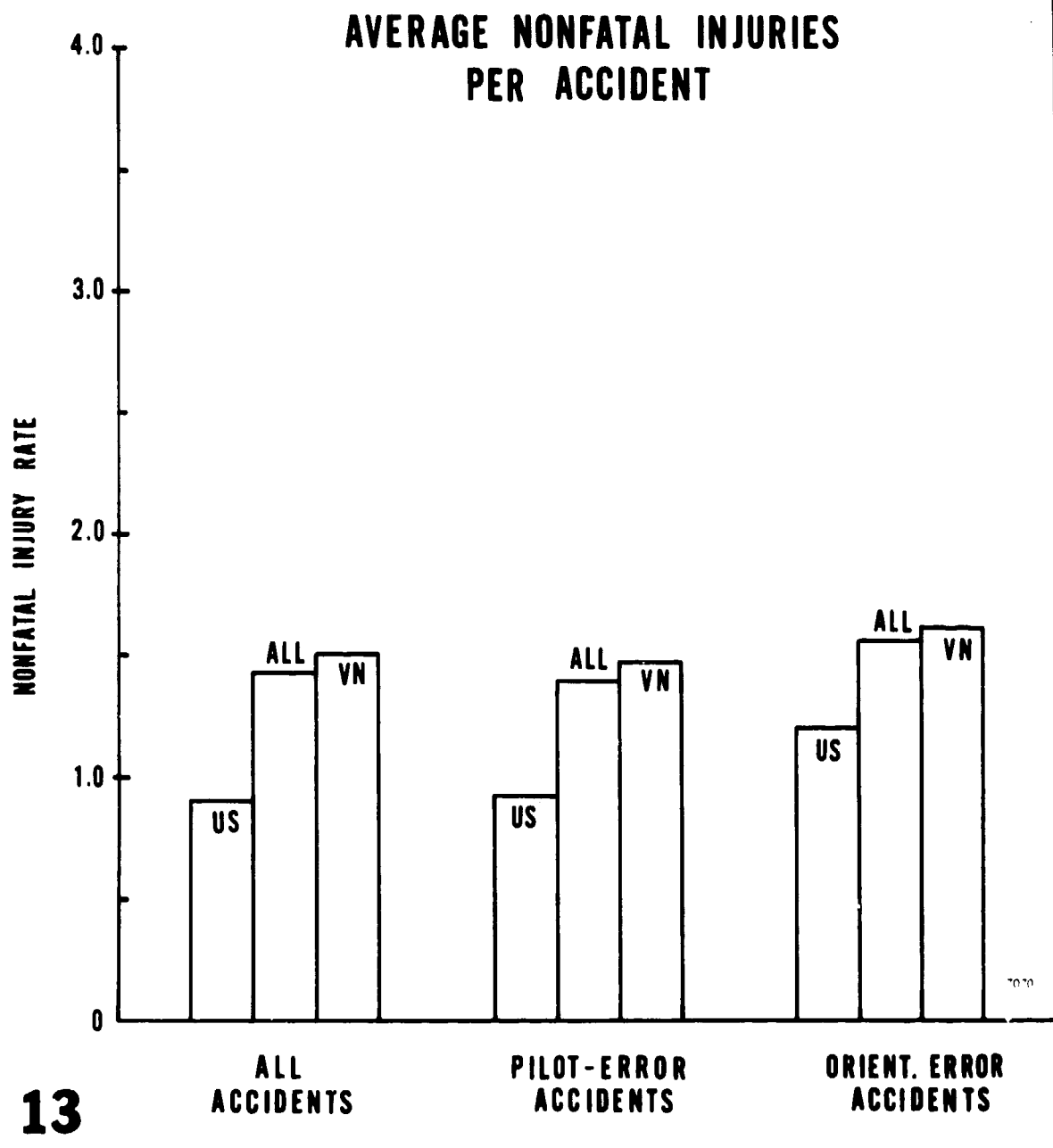


Figure 13

Average number of nonfatal injuries per accident for each of the three basic accident type classifications.

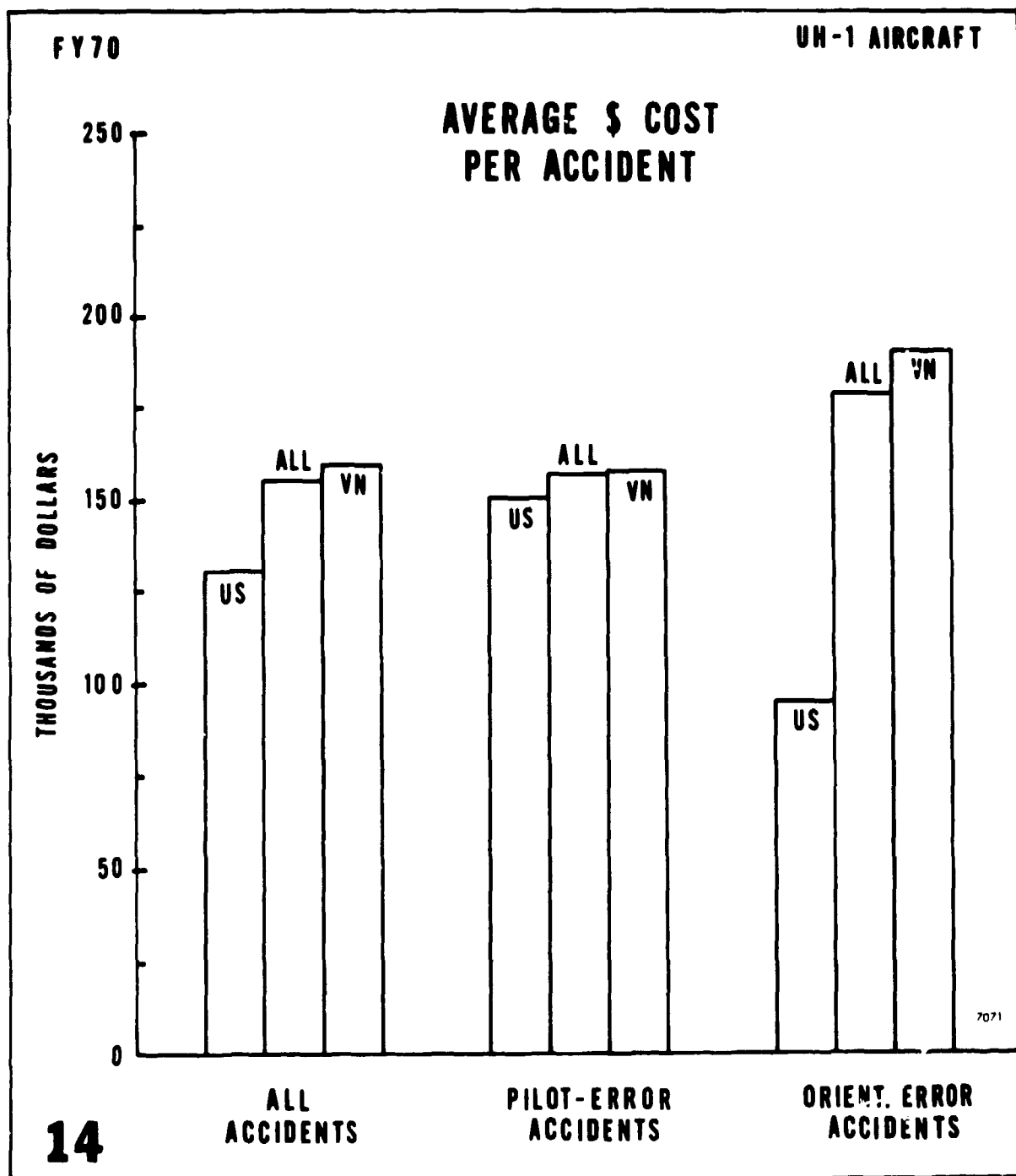


Figure 14

Average dollar cost of aircraft damage per accident for each of the three basic accident classifications. (Strike damage to a UH-1 aircraft approximates \$250,000.) The average cost of orientation-error accidents only slightly exceeds the cost of the other two accident classifications.

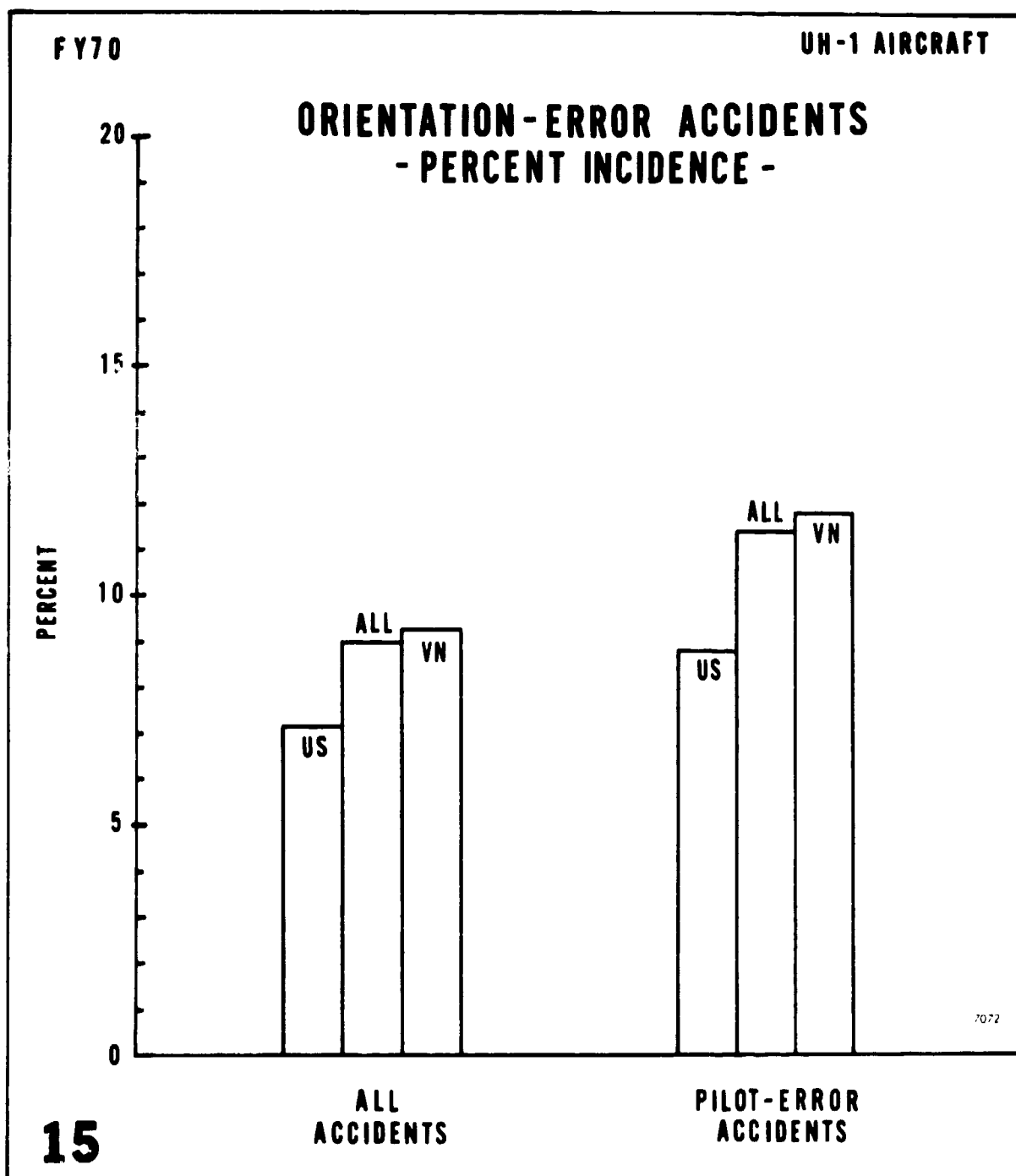


Figure 15

Percent contribution of all UH-1 orientation-error accidents to the total number of UH-1 accidents occurring within the "All Accident Type" and "Pilot-Error Accident Type" classifications. Orientation-error accidents accounted for 8.92 percent of all accidents and 11.35 percent of all pilot-error accidents.

FY70

UH-1 AIRCRAFT

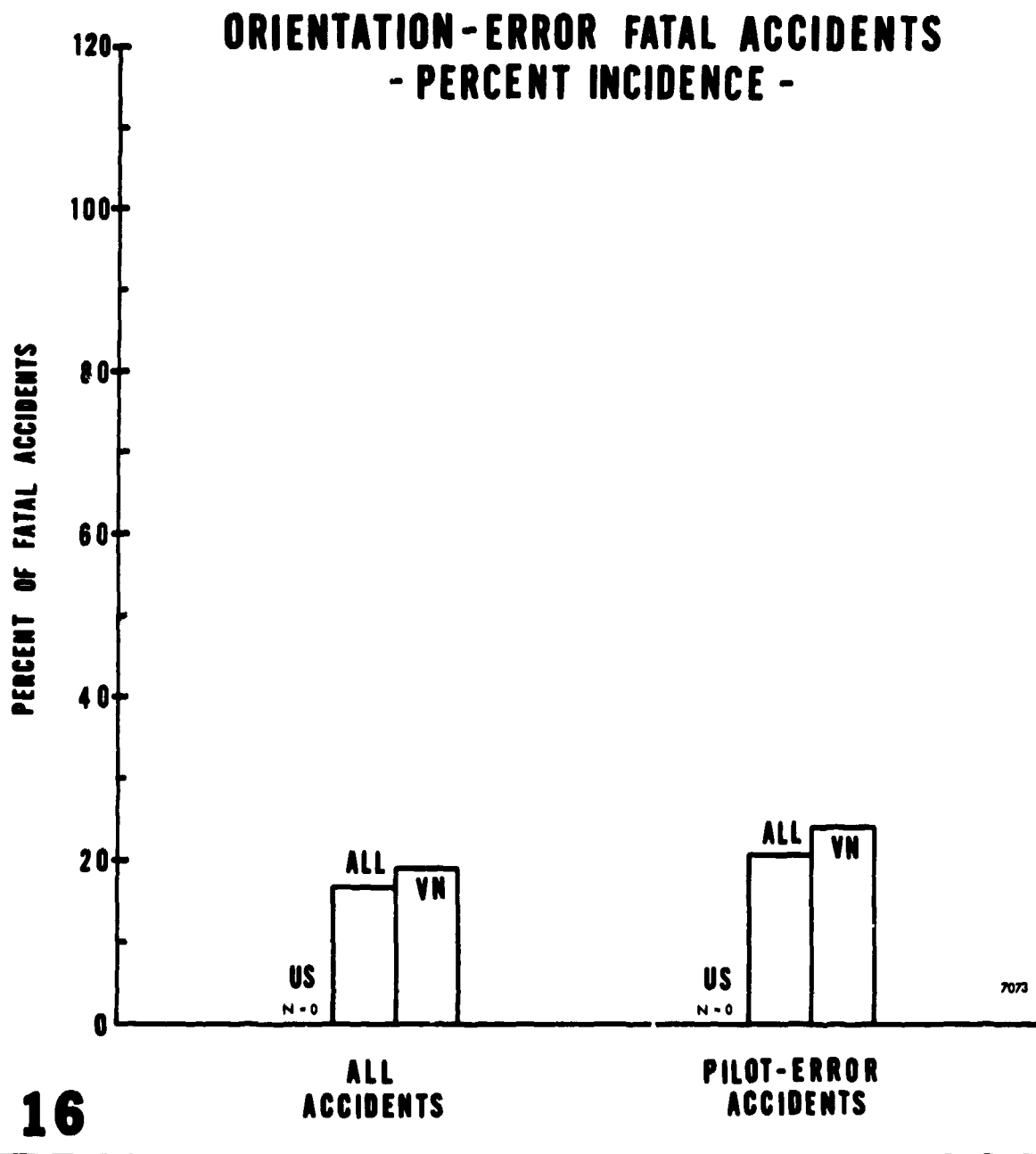


Figure 16

Percent contribution of fatal UH-1 orientation-error accidents to the total number of fatal accidents occurring within the "All Accident Type" and "Pilot-Error Accident Type" classifications. Fatal orientation-error accidents accounted for 16.67 percent of all fatal accidents and 20.73 percent of all fatal pilot-error accidents.

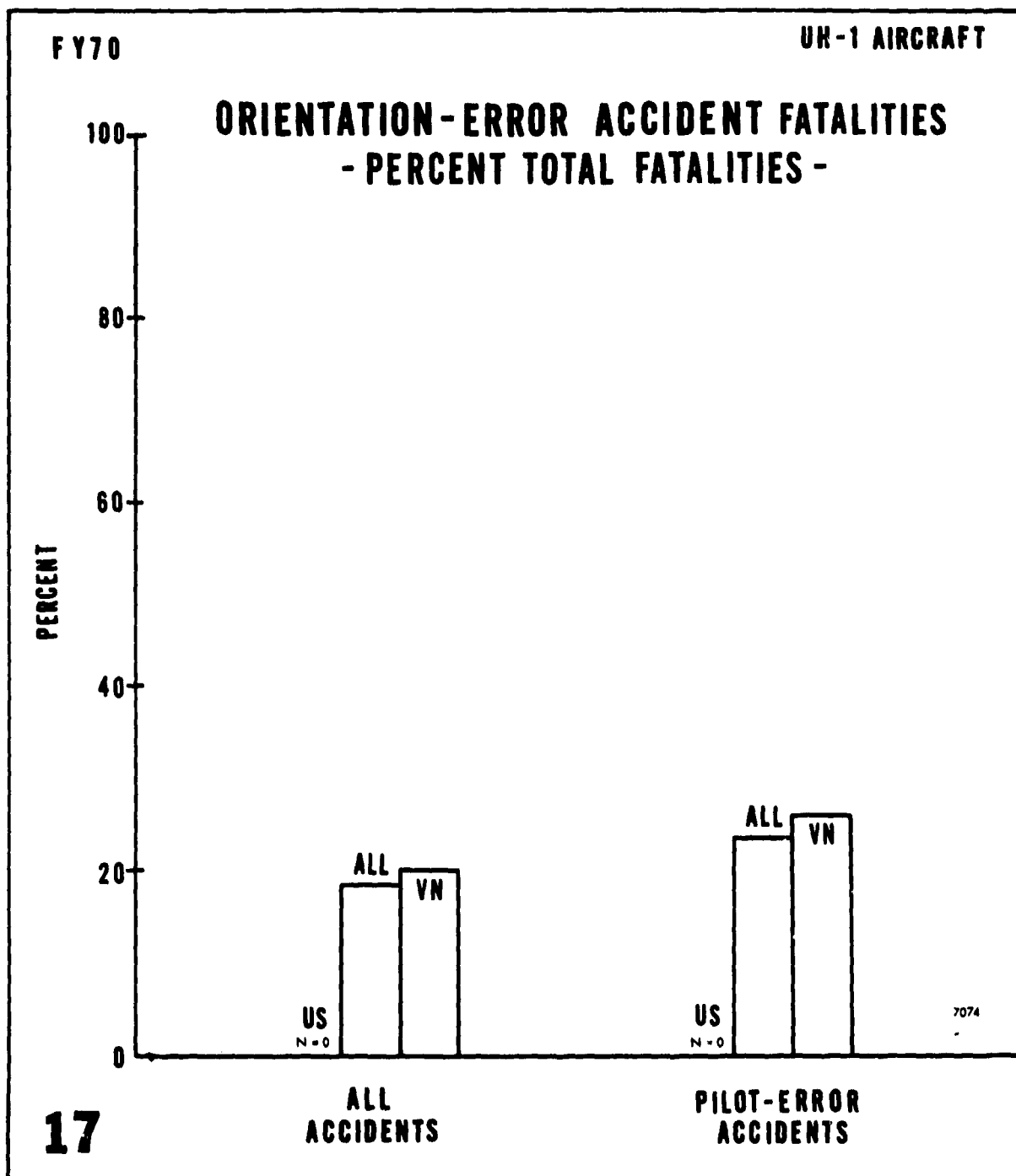


Figure 17

Percent contribution of all UH-1 orientation-error accident fatalities to the total number of fatalities occurring within the "All Accident Type" and "Pilot-Error Accident Type" classifications. Fatalities due to orientation-error accidents accounted for 18.33 percent of the total number of accident fatalities and 23.49 percent of the pilot-error accident fatalities.

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UH-1 AIRCRAFT

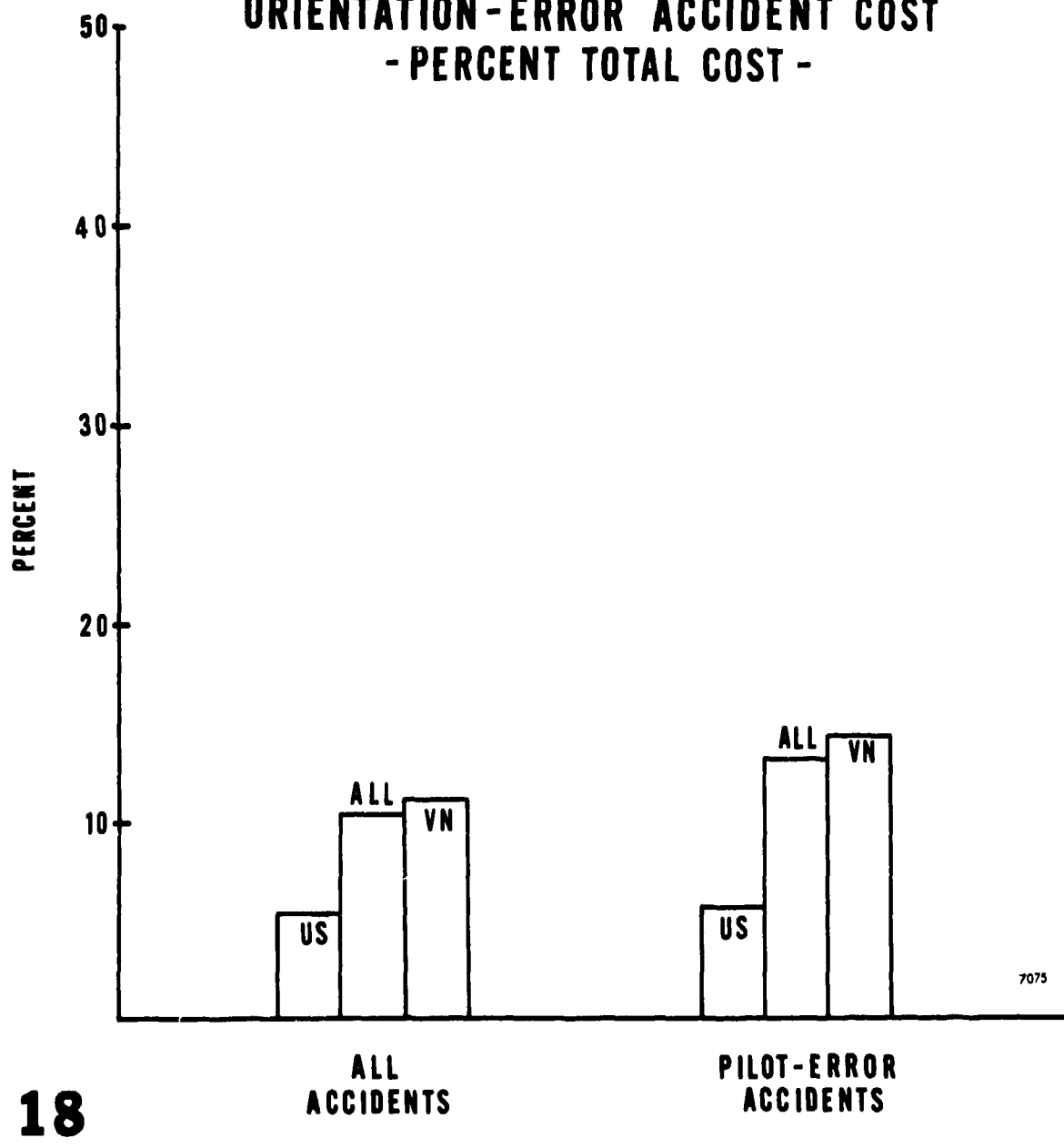
**ORIENTATION-ERROR ACCIDENT COST
- PERCENT TOTAL COST -**

Figure 18

Percent contribution of the total dollar cost of all UH-1 orientation-error accidents to the total dollar cost of all accidents occurring within the "All Accident Type" and "Pilot-Error Accident Type" classifications. The dollar cost of orientation-error accidents accounted for 10.28 percent of the total cost of all accidents and 12.96 percent of the total cost of all pilot-error accidents.

As with the previous UH-1 incidence and cost reports (refs. 2,5,8), a related report will be prepared to describe the various accident factors found to be present in each of the fiscal year 1970 major UH-1 orientation-error accidents. The format of this report will be identical to that of the previous factor reports (refs. 3,6,9).

At this point, no attempt will be made to draw any further conclusions as to the overall significance of the results since corresponding UH-1 data are under preparation for subsequent fiscal years. As stated previously (ref. 1), the long-term value of these data will depend upon whether the longitudinal analysis does or does not establish the presence of consistencies or trends in the accident experiences. Moreover, it is the function of this element of the longitudinal study only to provide quantitative UH-1 accident data; the evaluation of the data in terms of its mission implications must remain with those responsible for direction of military aviation operations.

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| 13. ABSTRACT This report is the fourth in a longitudinal series of reports dealing with the magnitude of the pilot disorientation/vertigo accident problem in Regular Army UH-1 helicopter operations. Incidence and cost data presented for fiscal year 1970 include a total of 43 major and minor orientation-error accidents (17 of which were fatal), resulting in 66 fatalities, 67 nonfatal injuries, and a total UH-1 aircraft damage cost of \$7,706,191. | | | |

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